Teacher at Sea Lesson Plan

Activity Title: "Mining" for Scallop Data

Subject (Focus/Topic): Marine Science Data Analysis

Grade Level: AP Environmental Science or AP Biology
With modification, other classes including biology, AP Statistics, etc. can make use of the lesson plan.

Average Learning Time: Several days of in-class time for students to work with the data and at least one-two days for student presentations of results. Additional out-of-class time will be required for students to create posters or presentations. The time is somewhat variable, depending on the depth of questions asked by students and the format of the data presentations.

Lesson Summary (Overview/Purpose): This activity is designed to introduce students to some of the challenges scientists face when asking environmental questions that involve a great deal of data and the major issues that revolve around what data is chosen and how that data is analyzed.

Overall Concept (Big Idea/Essential Question): Students will examine the types of data available and then design a research question that can be answered using that data. Students will perform additional background research on the organisms, relevant history and relevant national and international environmental policies related to the original question. At the conclusion of the research project, the class will produce either a scientific poster session or present their data as a series of slide presentations.

Specific Concepts (Key Concepts):
Scientific data is often complex in its raw form.
Choice of data and analysis is critical to the outcome of good scientific inquiry.
Presentation of scientific data is necessary to share the data with other scientists.

Focus Questions (Specific Questions):
How is fisheries research conducted?
What are the laws and treaties governing fishing in the North Atlantic?
How are the species found in the North Atlantic interrelated?

Objectives/Learning Goals:
Students will be able to design a research question based on available data.
Students will be able to determine what data is needed to answer a given research question.
Students will be able to run and interpret basic statistical analyses using Excel or other programs.
Students will be able to present the research question, data and its analysis, and conclusions in a scientifically appropriate manner.

Background Information:
This project is designed for AP Environmental Science students who are already familiar with the following topics:

1. Energy and mass flow through a food web
2. Ocean biomes and typical food webs found there
3. Aquatic biodiversity and the human impacts on biodiversity
4. Population ecology
5. Management practices in the US for maintaining biodiversity (EPA, Endangered Species Act, Clean Air Act, Clean Water Act, etc)
6. Commercial and recreational uses of marine habitats

Common Misconceptions/Preconceptions:

Students often struggle with asking good questions and selecting data to address the question. For many students, this type of research and presentation is completely new and they will need significant guidance. One misconception that occurs frequently is that data must "prove" a hypothesis. Students are not comfortable with the fact that the data often refute a hypothesis or that the answer to a question might be "no," or "it doesn't seem to work the way we thought it did." Reinforcement must be provided that the grade is not dependent on the answer to the question, but on the process and data used to reach the conclusion and on the presentation of that data. Too often, students work on labs that have only one "correct" answer and the students are convinced that any answer other than the expected is wrong. They are not accustomed to having to explain whatever data their experiment produces. In this exercise, the questions being asked are new (at least to the students) and do not have predetermined outcomes. Because of this, it is important for the teacher to resist the temptation to step in and give the students answers. Also, since the process of asking questions and then attempting to answer the question is the purpose, the teacher should allow the students to follow their own paths, even if she/he knows that the path will not lead to an answer.

Materials:

Large collection of raw data for students to access and choose from
Examples of scientific posters and/or presentations
Access to a color printer is helpful for printing poster panels
Optional:
Teacher at Sea: Mr. Tanenbaum Explores Atlantic Fisheries on the NOAA Ship Henry B. Bigelow by Diane Stanitski and John Adler, (2009) from NOAA publications.
Maps with latitude and longitude lines

Technical Requirements:

Computer access is required for data gathering, analysis and graphing, poster production, etc.
Access to Google Earth or other programs for plotting latitude and longitude
Each student group will need access to a computer

Teacher Preparation:

The most critical aspect of this lesson is that the teacher be completely familiar with the data the students are using. It is also very important for the teacher to be able to use the software and calculators available to run and interpret the statistical analysis the students will be using (mostly standard deviation, standard error, and other basic tests). It may be helpful for the teacher to produce an example of a scientific poster.

Sea Scallop survey data can be obtained from Bill Kramer, William.Kramer@noaa.gov, at NOAA. For each year requested, the station data set and at least one other data set will be needed. This lesson plan was designed with the station data, catch data, and length data from 1979 through 2010 available to the students. The station data includes latitude and longitude, tow length, stratum and tow number of each tow. The catch data includes what species were caught, the number and weight of each while the length data (from 2005 until 2010) includes the numbers of scallops at each length. The data will need to be requested well in advance of the project to allow time for the data retrieval and mailing a data disk to the school. The files are Excel formatted, but are quite large and can be problematic to send by email. If possible, a read-only set of the data should be posted to a central location accessible to the students electronically. Alternatively, students can submit a data request to the teacher and be provided with the data subset requested.

Keywords: Inquiry, Data mining, Fisheries management

Pre-assessment Strategy/Anticipatory Set (Optional):
This lesson should follow others covering Fisheries management, Biome descriptions, and basic oceanography.

Lesson Procedure:

All rubrics and handouts are appended to this document.

1. Introduce lesson by explaining that, due to the budget short-falls in the government, there would be fewer funded graduate positions available next year, and those would be awarded based on the research and poster presentations the candidates would carry out over the next weeks. Those not awarded funded positions would not be removed from the program, but would be required to fund their graduate work themselves.
2. Explain the process for gathering the sea scallop data using pictures from the 2010 Hugh R. Sharp cruise or the book: Teacher at Sea: Mr. Tanenbaum Explores Atlantic Fisheries on the NOAA Ship Henry B. Bigelow. Show examples of the available data.
3. Students are divided into teams of 2-3 and given the project outline and grading rubrics and 10-15 minutes to brainstorm ideas for questions and types of outside information needed to address those questions. After 15 minutes, ideas and sources/types of information are collected and listed on the board and additional ideas generated.
4. Once ideas are on the board, discuss which ideas might make good projects and why. Also discuss what types of information is needed to address the question. Remind students that many funding agencies are interested in projects that have a direct benefit. Local, national and international regulations and treaties covering the fishing areas are also important to address. Much of this will have been covered in earlier classes.
5. Show students examples of posters and make sure students understand the requirements for the poster and the date for the poster session.
6. Student groups are now free to begin developing the question for their project. All questions must be approved by the teacher to ensure that each group is working on a different question and that all of the questions are suitable. The teacher should use leading questions rather than outright statements to guide students to improve the quality of their questions. The same technique should be used to help the students determine what data and analyses are needed to address the question.
7. As all groups finalize a question, conduct a seminar covering the basics of standard deviation and standard error and, if needed, other statistical tests. Instructions for running these tests using Excel should be provided. If students are all co-registered for AP Statistics, this may not be necessary.
8. Provide students with access to the read-only data or provide the data each student group requests.
9. As work continues, circulate among the groups to provide guidance as needed. Due to the complexity of this project, most students will need regular guidance so additional class time is recommended.
10. A minimum of 1 more class day near the end of the project should be allocated for students to begin assembling their poster.
11. Ideally, posters should be hung in a public area the afternoon before the poster session. Also, if possible, have other classes, administration, parents, etc. present for the session. Students should take turns standing with their poster and walking around to see the other posters. A grading rubric for the poster presentations is attached.

Assessment and Evaluation:

Students are evaluated at several points during the lesson and are given the rubrics at the beginning of the project so that expectations are clear. The development of a good question is the first point of evaluation and is formative in nature; unacceptable questions are returned to student groups for additional work. Data selection and analysis are also partially formative in that students should consult with the teacher about the appropriateness of the data chosen and analysis planned. Students should be able to clearly articulate why they chose the particular data and analysis methods and how that addresses their original question. The final evaluation point includes the presentation of the research project to the rest of the class and the actual product (poster or presentation). Data presented by the students will also be included on the next formal test/exam to encourage close attention to all student presentations. Rubrics are attached to this plan.

Standards:

National Science Education Standard(s) Addressed:

The Interdependence of Organisms

LSInter 3: Organisms both cooperate and compete in ecosystems

LSInter 4: Living organisms have the capacity to produce populations of infinite size, but environments and resources are finite.

LSInter 5: Human beings live within the world's ecosystems

Unifying Concepts and Processes

UCP 2: Evidence, models, and explanation

UCP 3: Change, consistency, and measurement

Science as Inquiry

SI 1: Abilities necessary to do scientific inquiry

SI2: Understandings about scientific inquiry

Science in Personal and Social Perspectives

SPSP 2: Population growth

SPSP 3: Natural resources

SPSP 4: Environmental quality

SPSP 5: Natural and human-induced hazards

SPSP 6: Science and technology in local, national, and global challenges

Ocean Literacy Principles Addressed:

5: The ocean supports a great diversity of life and ecosystems

5e, 5f,

6: The ocean and humans are inextricably interconnected

6b, 6c, 6e, 6g

7: The ocean is largely unexplored

7b, 7c, 7d, 7e, 7f

AP Environmental Science Standards Addressed:

Themes: 1: Science is a process.

3A: Natural Systems change over time and space.

4: Humans alter natural systems

5: Environmental problems have a social and cultural context.

Topics: 1A: Earth Science Concepts (latitude)

1C: Global Water Resources and Use

2A: Ecosystem Structure

4F: Fishing

AP Biology Standards Addressed:

Big Idea 1 (Evolution): 1.A.1 and 1.A.2

Big Idea 2 (Energy and Homeostasis): 2.A.1, 2.D.1 and 2.D.3

Big Idea 3 (Information): 3.E.1

Big Idea 4 (Interaction): 4.A.5, 4.A.6, 4.B.3, 4.B.4, 4.C.2, 4.C.3, and 4.C.4

Science Practice 2: 2.1, 2.2, and 2.3

Science Practice 3: 3.1, 3.2, and 3.3

Science Practice 4: 4.1, 4.2 and 4.4

Science Practice 5: 5.1, 5.2, and 5.3

Science Practice 6: 6.1, 6.2, 6.3, 6.4, 6.5 and 6.6

Additional Resources:

A large data set must be available for the students. This project was designed to make use of the data available from the yearly Scallop Survey and includes data on dredge site (latitude and longitude), depth and length of dredge, species caught with weight and length on selected species from many years. The data set available will govern the breadth of the student questions.

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Creation Date: July 2010

Sea Scallop Project Outline

You are a graduate student in a Fisheries management research lab trying to get a federal grant. You need the grant to pay your salary so you don't have to leave research and get a job in the private sector teaching high school Environmental Science. In order to write the grant, you have to have some preliminary data and conclusions about your topic. You have been given access to a subset of the database of the Sea Scallop surveys that have been performed on a yearly basis since 1979.

1. Read this entire document. Read the rubrics you have been given! This data is important for your successful completion of this project.
2. Examine the samples and lists of data you have been given to get a good idea of what data is available.
3. In your group, develop a research question that can be answered by the data in the database. Remember that research questions are not simple questions, but ones that are open ended or ask for comparisons. 'How many scallops were present each year in stratum X?' is not a good question while 'What happens to species X and Y as the population of scallops changes?' is a much better question.
4. Once you have a question, get it approved by your advisor (teacher). This is worth 10 points of your final project grade.
5. You will be presenting your project to the rest of your class, so begin to prepare for that now. Look over the requirements and the sample poster and plan how you will address each requirement. What type of background information will you need for your introduction? What kind of data will you need to answer your question or test your hypothesis? How are you going to organize that data? How will you phrase your request for data so that you get what you need? What analysis is needed? How do you relate what you found to the 'real' world? What are the relevant regulations (local, national, international) involved in your data? What about open vs. closed fishing areas and/or endangered species? Is there a potential effect on commercial or recreational fishing? Remember that the government doesn't often pay for studies with no relevance.
6. Discuss your plan with your advisor and then request your data and begin your research. Continue to consult with your advisor and your fellow students as you work with the data and do your analysis. This communication is also a part of your grade.
7. Produce your poster and prepare your presentation. This poster session is your one chance to get that grant you need, so make sure it and you look professional on presentation day. Imagine that someone, Dr. Rankin for example, walks up to your poster and says "Tell me about your project."

Poster Data Requirements:

1. Abstract – A single-spaced paragraph of no more than 250 words that is a project summary. It will briefly cover all of the areas described below, except the reference section.
2. Introduction/Background – This section covers all of the basic information leading up to your question. It sets the perspective for your question. Information (from basic biology to commercial use) about the species involved, relevant legislation, and environmental problems specific to the species or the area, etc. should all be included. You will need to include your citations in APA format. Think bullet points rather than paragraphs.
3. Methods – Explain what you did. Give enough detail for someone with basic knowledge of the field to be able to repeat your project. Again, think bullet points, not paragraphs. You do not have to put in steps that are self-evident such as 'type the data into an Excel spreadsheet,' instead write 'data were analyzed in Excel using X test.'
4. Results and Analysis – Present all of your data in this section. Data should be presented in graph or table format with all labels, titles, and figure legends present. Graphs should have error bars if appropriate. A paragraph explaining your analysis methods is also necessary. You do not have to give the equations for standard statistical analyses.
5. Discussion – This is where you explain your results. This is the section that answers the question 'Why did I get this answer from the data?' Explain what your data mean and apply that answer to the original question you developed. How does this answer affect the management of the fishery? Does your data support projects anyone else has done or does your data contradict others? How do you explain any contradictions? This section should also address any unusual data or data that does not make sense. What needs to happen next? Apply your data to the 'real world.' You may need additional references in this section.
6. References – This section should include all of your references in APA format.

Poster Physical Requirements:

Most of the grade is based on your data and analysis, but looks do count and it MUST be legible at least an arm's length away from the poster.
Your poster must fit in a 4ft x 4ft space.
You need a title and authors banner.
Print the parts and mount on colored construction paper. Make sure all corners are attached – nothing says unprofessional like a poster that is falling apart!
The exact placement of the sections is up to you, but it must flow logically and tell your story logically.
Test-hang or measure your poster before you get to the presentation day to make sure that it fits!

Sea Scallop Poster Session Rubric

CATEGORY	4	3	2	1
Requirements	All requirements are met and exceeded.	All requirements are met.	One requirement was not completely met.	More than one requirement was not completely met.
Organization	Content is well organized using headings or bulleted lists to group related material.	Uses headings or bulleted lists to organize, but the overall organization of topics appears flawed.	Content is logically organized for the most part.	There was no clear or logical organizational structure, just lots of facts.
Content	Covers topic in-depth with details and examples. Subject knowledge is excellent.	Includes essential knowledge about the topic. Subject knowledge appears to be good.	Includes essential information about the topic but there are 1-2 factual errors.	Content is minimal OR there are several factual errors.
Sources	Source information collected for all graphics, facts and quotes. All documented in desired format.	Source information collected for all graphics, facts and quotes. Most documented in desired format.	Source information collected for graphics, facts and quotes, but not documented in desired format.	Very little or no source information was collected.
Mechanics	No misspellings or grammatical errors.	Three or fewer misspellings and/or mechanical errors.	Four misspellings and/or grammatical errors.	More than 4 errors in spelling or grammar.
Data Presentation	All data is appropriately displayed (table and/or graph) with appropriate headings and labels. All statistical analysis is correct and appropriate.	All data is appropriately displayed (table and/or graph) with appropriate headings and labels. Most statistical analysis is correct and appropriate.	All data is appropriately displayed (table and/or graph) with appropriate headings and labels. Appropriate analysis is minimal or has errors.	All data is appropriately displayed (table and/or graph) with appropriate headings and labels. No analysis is present or is inappropriate.
Attractiveness	Makes excellent use of font, color, graphics, effects, etc. to enhance the presentation.	Makes good use of font, color, graphics, effects, etc. to enhance to presentation.	Makes use of font, color, graphics, effects, etc. but occasionally these detract from the presentation content.	Use of font, color, graphics, effects etc. but these often distract from the presentation content.
Oral Presentation	Interesting, well-rehearsed with smooth delivery that holds audience attention.	Relatively interesting, rehearsed with a fairly smooth delivery that usually holds audience attention.	Delivery not smooth, but able to hold audience attention most of the time.	Delivery not smooth and audience attention lost.